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RFID's Impact on Logistic Operations: Towards a Comprehensive Empirical Assessment

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ABSTRACT

Radio Frequency Identification (RFID) is an information technology whose appeal to practitioners and researchers remains high. Although an impressive amount of research addresses its use in various applications, its impact on logistic operations, where it is expected to yield the most significant benefits, has been poorly understood to date. In particular, stringent empirical research along these lines is still missing and many questions remain unanswered. Which generic activities are crucial when introducing RFID in logistic processes? Are detailed planning, expertise, standards, and collaboration with business partners actually essential to achieve RFID profitability or is RFID introduction easier than expected by most decision makers. Does most of the value created by RFID projects come from improved automation, visibility, or completely new ways to do business? In order to answer these questions, we have designed a survey instrument which is described and evaluated in this paper[1]. The hypotheses motivated in this document will soon be tested using a representative sample of RFID adopters and the structural equation modelling methodology.

Keywords (Required)

RFID Success, IT Value, Logistics, Empirical Study

INTRODUCTION

While the use of RFID has become a standard in a number of application niches such as e-ticketing (ski passes, drive through payment, etc.) the application of RFID in logistics is still relatively new. The majority of potential implementers still hesitate to integrate the technology into their logistic processes – in particular due to fears of missing profitability goals or technological problems. A better understanding of success factors and their relative importance could increase our understanding of the actual value creation process triggered by RFID adoption and help practitioners to set the right priorities with respect to RFID introduction. Against this background, we believe that a major task waiting to be addressed by Information System (IS) research is to empirically investigate the RFID value creation process in the logistics domain.

MODEL DEVELOPMENT

Since our study breaks new ground, we had little previous research to base our theories on. We used various information sources to develop and triangulate a conceptual model that allows us to investigate how RFID affects business performance.

Literature Research

Most of the literature related to our research topic originates from one of the two areas: (i) the well-grounded empirical literature on the success of IS and (ii) the large but both theoretically and methodologically less developed literature about RFID.

In the first area, we found various empirical studies ranging from generic information systems to very specialized IS success studies, e.g., Enterprise Resource Planning (ERP) (cf. Nah et al. 2003) or data warehouse systems (cf. Wixom and Watson 2001). Although these studies provided a useful starting point for defining a suitable research model for RFID success, we

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came to the conclusion that the integration of RFID into the enterprise landscape significantly differs from the introduction of IS. What can make RFID valuable is its embedment into the physical, system, process, and organizational environment of the implementing company.

The existing RFID literature focuses on identifying benefits of the technology (Lee and Özer 2007; Attaran 2007; Roh et al. 2009) and proposing solutions for open technological problems and standardization issues (cf. EPCglobal 2009; EPCglobal 2008). The benefit creation process induced by the adoption of RFID in logistic operations has to date been investigated using qualitative case studies (see Thiesse and Condea 2009 for an overview) and model-based research (see Lee and Özer 2007 for an overview). Furthermore, a number of researchers have conduced empirical analyses investigating reasons and drivers of RFID adoption (see Wu et al. 2006; Huyskens and Loebbecke 2007; Curtin et al. 2007). To the best of our knowledge, post-adoption empirical research on the success of RFID implementations, i.e., RFID's business success, has so far not been undertaken leaving a research gap that needs to be filled. Literature directly related to certain variables and hypotheses implied by our research model is cited in the corresponding passages in the Final Conceptual Model Section of this paper.

Expert Interviews

After we had completed the initial literature review and had developed a first listing of variables, we conducted interviews with four RFID experts to triangulate our findings. All questioned experts have several years of RFID experience and have been involved in actual RFID implementation projects.

The expert interviews were conducted face to face or via the phone and lasted 45 minutes on average. Each interview was divided into three parts: in the first part, we asked general questions about the background of the interview partners and their experiences with the RFID technology in the logistics domain. This was done in order to identify individual biases that may affect their responses. The second part of each interview focused on RFID implementation issues and RFID value. In particular, we focused on the exploration of positive as well as negative influences, both technical and organizational. Afterwards, we asked the experts about the major types of benefit that RFID can provide to companies.

Overall, the expert opinions supported the inclusion of the presented variables and no additional variables were proposed. However, we observed differences in the way the experts viewed the importance of the variables.

One expert emphasized the importance of organizational integration, i.e., the mutual amplification of technology acceptance and further integration into business processes. On the other hand, all experts agreed that the efficient management of RFID data and the creation of interfaces between RFID systems and existing ERP systems was a major challenge in the projects they participated in. As far as the impact of RFID is concerned, the experts mentioned automation effects, such as time and labor cost savings, as well as information effects, like improved control of logistic systems. However, they also pointed out that the most important long run effect of RFID will be process transformation or even completely new ways of doing business. Currently, however, only few companies have been able to realize this effect in their opinion. According to the experts, a major reason for this situation is a lack of data and process integration, which is still only scarcely supported by adequate standards and tools. In the third and last part of the interview, we addressed specific questions about the variables we identified during our literature research. In particular, we asked for the experts' opinion on possible dependencies and relationships between the individual variables. The major findings of this part of the interviews, i.e., the expert feedback directly related to our research model, are provided in the corresponding passages of the Final Conceptual Model Section.

Scale Identification and Validation

After our literature research, the model and hypothesis development, and the triangulation of the model with the help of expert interviews, we had created a model with 19 variables (see Table 2). In the next phase of the model creation process, we identified corresponding measurement scales. In doing so, we applied a slightly modified version of Moore and Benbasat's (1991) approach, i.e., we first identified scales of existing IS survey instruments and assigned them to the variables of our model. We built scale pools of 10 scales for each variable. For some RFID specific variables, we could not find applicable scales in literature; therefore, we had to develop them from scratch. Eventually, we ended up with 190 scales measuring our 19 variables. Once the scale pools were created, we carefully redesigned or eliminated those that appeared too redundant or ambiguous. After this procedure, 116 scales remained, which were evaluated with the help of six RFID project managers and RFID researchers. In an online evaluation, the participants were asked to rate both, the understandability of the scales and their thematic fit on a 5-point Likert scale ranging from one (very good) to five (very bad). In Table 1 the medians of the six samples are on display. As indicated in Table 1, the understandability of 19 scales and the thematic fit of 8 scales were rated below good (2.5 and less). Therefore, we decided to either eliminate or redesign those particular scales.

After that, we started a second evaluation round for the scales using category shuffling as proposed by Moore and Benbasat (1991). In particular, we asked two RFID experts, two PhD-level RFID researchers, and two students for assigning the remaining 86 scales to the 19 categories. Out of the 516 assignments – the 86 scales multiplied by the number of the six judges – 294 were allocated correctly leading to a hit ratio of 57% (see Table 2). More informative than the overall hit ratio were the individual assignments to the different variables. Especially the variables *Promotion of RFID Acceptance*, *Availability of Resources*, *Integration Scope*, and *RFID Organizational Success* showed poor hit ratios of 40%, 46%, 13%, and 23%, respectively. The main false categorizations occurred between the variables *Management of RFID Data* and *Integration of RFID Hardware* and between *RFID Organizational Success* and *Promotion of RFID Acceptance*.

	Scales								
	very good		good		more or less		bad		very bad
Criteria	1	1.5	2	2.5	3	3.5	4	4.5	5
Understandability	9	9	79	6	13	0	0	0	0
Thematic Fit	22	22	64	4	4	0	0	0	0

Table 1: First Round of Scale Evaluation: Understandability and Thematic Fit

Target Category		Actual Category																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOT	TGT
Promotion of RFID Acceptance	1	12	3	0	1	0	0	1	1	0	0	0	5	2	3	0	1	0	0	1	30	0.4
Adaptation of Business Processes to RFID	2	0	18	1	0	2	0	1	1	0	1	1	2	0	0	2	0	0	0	1	30	0.6
Management of RFID Data	3	0	1	15	7	0	0	1	0	0	1	0	0	0	2	2	0	0	1	0	30	0.5
Integration of RFID Hardware	4	0	0	0	17	0	1	0	1	0	0	0	2	1	0	2	0	0	0	0	24	0.71
RFID Information Effect	5	0	0	0	0	17	1	0	2	0	1	0	0	1	0	0	0	1	1	0	24	0,71
RFID Automation Effect	6	0	0	0	0	5	25	0	2	1	0	1	1	0	1	0	0	0	0	0	36	0.69
RFID Transformation Effect	7	0	0	0	0	1	1	19	6	1	0	0	0	0	1	0	0	1	0	0	30	0.63
RFID Business Success	8	0	1	0	0	0	5	0	21	0	0	0	0	0	0	2	0	1	0	0	30	0.7
Effectiveness of RFID Project Management	9	0	0	0	0	0	2	1	5	14	2	2	1	0	1	0	0	0	0	2	30	0.47
Ex-ante Evaluation	10	0	0	1	2	1	0	0	0	1	22	0	2	1	1	0	1	2	1	1	36	0.61
Top Management Support	11	0	0	0	0	1	0	0	0	0	0	15	0	1	0	0	0	0	1	0	18	0.83
Availability of Resources	12	0	0	0	0	1	0	0	0	3	0	0	11	0	2	0	0	6	0	1	24	0.46
Availability of Expertise	13	0	0	0	2	0	0	0	1	1	0	2	1	18	5	0	0	0	0	0	30	0.6
Involvement of Business Partners	14	0	0	0	0	0	1	0	0	0	0	1	0	0	14	1	1	0	0	0	18	0.78
Integration Scope	15	0	3	0	0	1	0	1	3	1	0	0	0	0	0	3	1	5	0	6	24	0.13
Use of RFID Standards	16	0	0	0	0	0	0	1	1	0	2	0	0	0	0	1	18	0	1	0	24	0.75
RFID Project Success	17	0	0	1	1	0	0	1	2	4	1	0	1	0	1	0	0	16	0	2	30	0.53
RFID Technical Success	18	0	0	0	0	0	1	0	0	0	0	2	0	0	0	1	0	2	12	0	18	0.67
RFID Organizational Success	19	9	3	1	0	1	0	1	0	1	0	1	0	1	0	1	0	3	1	7	30	0.23
Total Item Placements		516																				
Hits		294																				
Overall Hit Ratio		0.57																				

Table 2: Second Round of Scale Evaluation: Category Shuffling

In their article about the development of measurement instruments Moore and Benbasat (1991) mention Cohen's kappa as a good statistical measure of agreement on categorical ratings. However, since Cohen's kappa works only for two judges, we

used the Fleiss kappa, in particular Brennan and Prediger's (1981) free-marginal kappa for inter-judge agreement. According to them, this index should be applied if judges are not forced to assign a certain number of scales to each category, just like in our case. Todd and Benbast (1991) mention that scores of 65% should be an acceptable level of agreement between the judges. However, we only achieved a free-marginal kappa of 37%. Accordingly, we decided to rework our survey instrument once again. In particular, we deleted the variables *Availability of Resources* and *Integration Scope* because they showed significant overlap with other variables. The false categorization of *Organizational Success* and *Promotion of RFID Acceptance* can be explained by the fact that both variables try to measure similar things, but at different points of time. *Promotion of RFID Acceptance* is an *Introduction Activity* and thus refers to the implementation time whereas *RFID Organizational Success* measures the result of the *Introduction Activities* and thus refers to the time after the project completion. Due to the inevitable similarities with respect to wording, this difference was not always recognized by the participants of the evaluation. However, we figured that this will not be a problem in the actual survey. Finally, all scales in the categories that displayed a hit ratio of below 70% were checked and reworked.

With these 17 variables and 73 scales, we conducted a second round of category shuffling (see Table 3). We used a similar composition of the focus groups as in the first round. The results of the third round of scale evaluation were clearly better than in the first round of category shuffling with an overall hit ratio of 75% and a free-marginal kappa of 59%, which represents an improvement of 18% and 22%, respectively.

Target Category		Actual Category																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	TOT	TGT
Promotion of RFID Acceptance	1	22	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	30	0.73
Adaptation of Business Processes to RFID	2	0	26	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	30	0.87
Management of RFID Data	3	0	1	22	3	0	0	0	0	1	1	0	1	0	0	0	1	0	30	0.73
Integration of RFID Hardware	4	0	0	0	18	0	1	0	0	0	2	0	1	0	0	0	2	0	24	0.75
RFID Information Effect	5	0	0	0	0	19	0	2	1	0	0	0	0	0	0	0	0	2	24	0.79
RFID Automation Effect	6	0	1	1	0	1	19	3	3	0	0	0	0	0	0	0	0	2	30	0.63
RFID Transformation Effect	7	0	1	0	0	0	0	21	2	0	0	0	0	0	0	0	0	0	24	0.88
RFID Business Success	8	0	0	0	0	0	5	3	26	0	0	0	0	0	0	0	0	2	36	0.72
Effectiveness of RFID Project Management	9	0	0	0	0	0	0	0	0	13	1	2	0	0	0	3	0	5	24	0.54
Ex-ante Evaluation	10	0	0	0	0	0	0	0	0	1	19	1	0	0	0	2	1	0	24	0.79
Top Management Support	11	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	18	1
Availability of Expertise	12	0	0	0	0	0	0	0	0	1	0	0	26	3	0	0	0	0	30	0.87
Involvement of Business Partners	13	0	0	0	0	0	0	0	0	1	0	0	0	17	0	0	0	0	18	0.94
Use of RFID Standards	14	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	24	1
RFID Project Success	15	0	0	0	0	0	0	0	3	6	2	0	0	0	0	19	0	0	30	0.63
RFID Technical Success	16	0	2	0	0	0	0	0	0	1	0	0	0	0	0	2	12	1	18	0.67
RFID Organizational Success	17	8	0	0	0	0	0	1	0	3	0	2	0	0	0	1	0	9	24	0.38
Total Item Placements 438																				
Hits 330																				
Overall Hit Ratio 0.753																				

Table 3: Third Round of Scale Evaluation: Category Shuffling

Despite the observed improvements, the variables *Effectiveness of RFID Project Management* and *RFID Organizational Success* were clearly below the 70% hit ratio. *RFID Automation Effect, RFID Project Success*, and *RFID Technical Success* were only slightly below this ratio level but we considered the corresponding hit ratios sufficient for our final survey (the reason for the low hit ratio of *Organizational Success* and its high fail categorization with *Promotion of RFID Acceptance* was explained before). The major fail categorization occurred between *RFID Business Success* and *RFID Automation Effect, Effectiveness of RFID Project Management* and *RFID Organizational Success,* and between *RFID Project Success* and *Effectiveness of Project Management.* In order to resolve the remaining model deficits, we decided to remove the variable *Effectiveness of RFID Project Management* since its items appear to be strongly correlated with the items of the variables

RFID Organizational Success and *RFID Project Success*. Finally, all scales that displayed a hit ratio of below 70% as well as the scales of *RFID Business Success* were checked and reworked.

Summarizing, the final survey instrument consisting of 16 variables and 69 measurement scales is the result of 4 improvement rounds (one round of author judgement, one round of direct expert judgement, two rounds of expert indirect judgement) which increased the parsimony of the proposed instrument by 63% with respect to the number of items and 16% with respect to variables. With regard to the improvement after the first round of category shuffling and scale reengineering of approximately 20% in the free-marginal kappa and overall hit ratio, we are confident that the quality of the final scales is now sufficient for conducting the actual survey. All scales are published on our website (Kunz and Goebel 2009).

THE FINAL CONCEPTUAL MODEL

By combining the results of the literature study, the expert interviews, and the scale evaluation, we synthesized a final conceptual model consisting of 16 variables which can be clustered into different categories (see Figure 1). A detailed description of the different variables and their categories is provided in the following paragraphs.

RFID Business Success

The main dependent variable of our model is *RFID Business Success*. This variable measures the perceived net benefits that are achieved through the introduction of RFID and has been used by many authors who contributed to the IT system success literature (Chwelos et al. 2001; Delone and McLean 2003; Bernroider 2008; Grandon and Pearson 2004; Stacie et al. 2008). The updated Delone and McLean (2003) model of IS success and later adaptations of this model (e.g., Bernroider 2008) use the net benefits variable as the indicator of system success because "it captures the balance of positive and negative impacts […]" (Delone and Mc Lean 2003). In addition to the items measuring the perceived success of the technology, we ask for a number of key quantitative success indicators, e.g., the return on investment of the RFID project or the percentage reduction of operational cost.

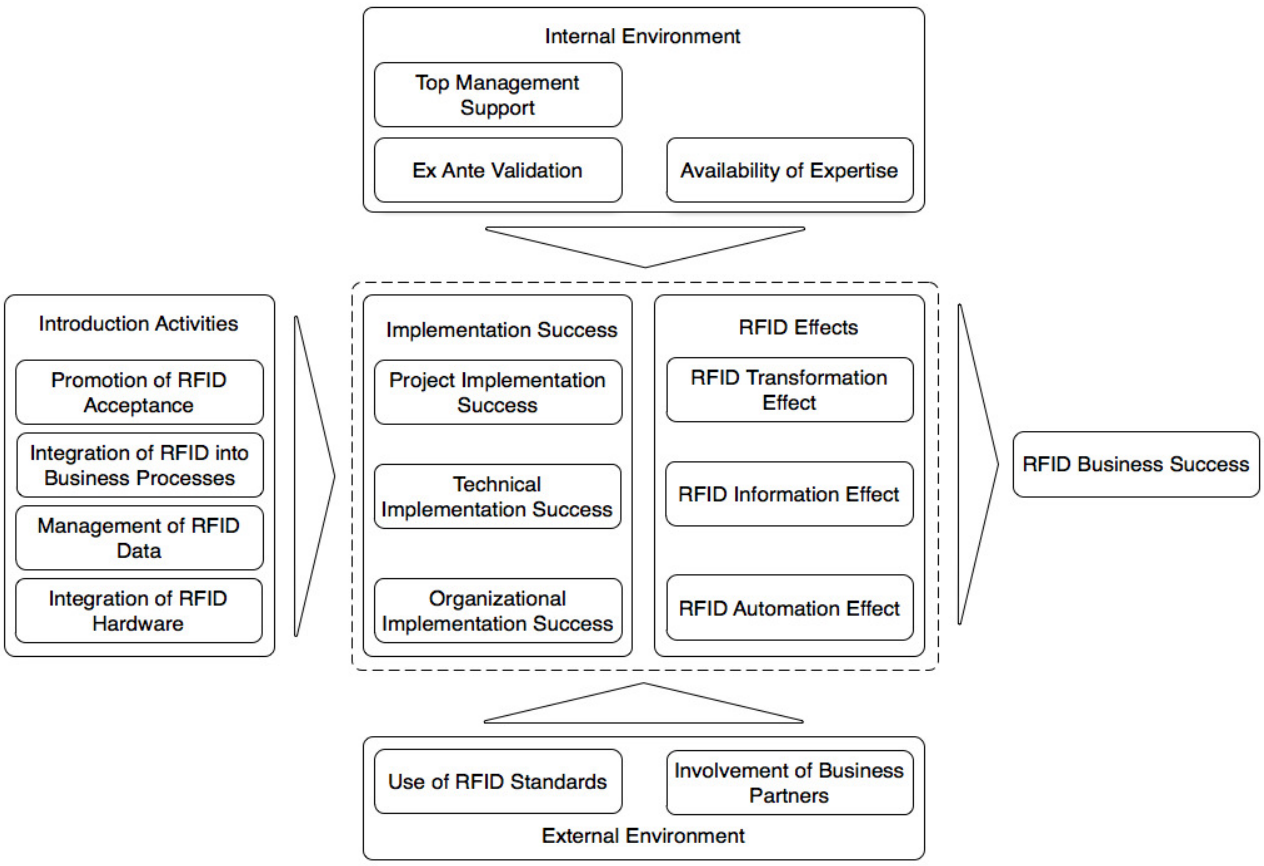

Figure 1: Conceptual Model of RFID Success Factors

RFID Implementation Success

In their study of critical success factors for ERP implementation, Hong and Kim (2002) measure *Implementation Success* by the variables cost, time, performance, and benefits. Wixom and Watson (2001) apply a much more diversified approach for measuring *Implementation Success* by dividing it into *Project Implementation Success*, *Technical Implementation Success*, and *Organizational Implementation Success*. We decided to apply the general categorization by Wixom and Watson (2001) and supplemented it with Hong and Kim's (2002) approach.

Project Implementation Success measures how well the project goals with respect to time and budget have been fulfilled (Wixom and Watson 2001). Wixom and Watson (2001) state that "Success with project goals can be measured by how well the team meets its critical time, budgetary, and functional goals". Hong and Kim (2002) mention that the performance of the project team can be measured by the perceived deviation from the defined project goals such as cost overrun, time, etc. In our interviews all experts supported the hypothesis that *Project Implementation Success* has a positive impact on *RFID Business Success*.

The variable *Technical Implementation Success* measures the degree to which the technical project goals have been achieved (Wixom and Watson 2001). RFID systems are complex systems that have to be integrated into the existing physical and IT infrastructure of a company. Technical problems can thus emerge at many occasions during RFID introduction. Hong and Kim (2002) mention system performance as well as the degree to which the expected functional requirements are fulfilled as measure for the attainment of technical objectives. Our instrument allows to empirically test the hypothesis that *Technical Implementation Success* has an influence on the overall *RFID Business Success*.

As stated by Wixom and Watson (2001) *Organizational Implementation Success* measures how well RFID technology was integrated into business practices and how well it is received by employees. The implementation of RFID can lead to considerable organizational change (e.g., business processes or work practices) that employees tend to resist. With increasing scope and magnitude of the changes, the likelihood for the acceptance of these organizational changes decreases. Further, resistance to change comes from the change in the job content and uncertainty about the new system (cf. Hong and Kim 2002). Without support of the employees, the RFID project is more likely to fail eventually, even if the functional and technical objectives have been achieved.

RFID Effects

In order to elucidate the RFID value creation process, we consider a trilogy of 'effects' ascribed to RFID: the *Automation*, *Information*, and *Transformation Effect*, which originate from the work by Mooney et al. (1996) and Tellkamp (2006, pp. 110 ff), and whose importance has recently been highlighted by publications of Baars et al. (2008) and Thiesse et al. (2009).

The *RFID Automation Effect* measures the increase of speed, efficiency, and reliability of the data capturing process resulting from the use of RFID. RFID often provides the opportunity to eliminate handling effort in process steps that involve manual data capturing. Our review of the RFID literature revealed that, on the one hand, the use of RFID reduces the necessity of conducting typical search and identification activities manually or in person which can result in time and labor cost savings; on the other hand, RFID-enabled automation bears the potential of streamlining transaction processes thus increasing the overall throughput of the corresponding facilities (Baars et al. 2008). The experts agreed that the *RFID Automation Effect* has a significant impact on *RFID Business Success*.

According to Tellkamp (2006, pp. 110 ff) the *RFID Information Effect* measures the increase of data quality resulting from the use of RFID. This type of effect has also been considered in previous work on system success, e.g., Wixom and Watson (2001). When discussing the effects of RFID with the experts, they mentioned the increased visibility provided by RFID, i.e., being able to track assets in real time. This increase of transparency allows steering processes more effectively and enables managers to spot and solve problems more efficiently.

The *RFID Transformation Effect* measures the degree of process transformation and business innovation enabled by the use of RFID. Process transformation refers to the reengineering of business processes that is only possible using RFID (Baars et al. 2008). Business innovation refers to the realization of new business processes that create additional value for the company (e.g., customer service add-ons); Tellkamp (2006, pp. 113 f) states that RFID technology" [...] can also make it economically feasible to realize new processes". In our interviews, the experts agreed that the highest business value will be created through the *RFID Transformation Effect* in the long run.

RFID Introduction Activities

RFID Introduction Activities measure the effort that companies invested into the respective activities in the course of RFID introduction and which where addressed in different domains in the context of IS research.

The variable *Promotion of RFID Acceptance* measures the degree of effort that the respective company invested into explaining RFID's value to all involved employees. It also measures the involvement of the employees in hands-on activities in order to 'make the most' of the technology. According to the questioned experts, RFID applications that support logistic operations are often not technically mature and thus require the active support of employees to be realized. The majority of the experts agreed that *Promotion of RFID Acceptance* has a positive impact on the *RFID effects*. Especially its impact on *RFID's Transformation Effect* was emphasized.

Integration of RFID into Business Processes measures the effort undertaken by the company to integrate RFID into existing processes and to adapt existing processes in order to realize RFID's value. We hypothesize that this variable has an important influence on the *RFID Effects* as well as on the *Implementation Success*. This hypothesis was backed by all interview partners. In their study about innovation diffusion factors, Bradford and Florin (2003) mention 'Business Process Reengineering' as possible success factor for ERP system implementations.

Through the variable *Management of RFID Data*, we intend to measure the effort undertaken by the company to manage RFID data in a way such that it can be used in business applications. Since corresponding data standards, in particular EPCglobal's EPCIS standard (EPCglobal 2009; EPCglobal 2008), have only recently been specified, compatibility with existing enterprise software is not guaranteed. In our interviews, the experts confirmed the importance of the Management of RFID Data. In particular, they assumed a strong positive impact on *RFID's Information Effect* as well as on the *Technical Implementation Success*; without a sound *Management of RFID Data* no additional information will be available. This may in turn have a negative impact on *Implementation Success.*

The variable *Integration of RFID Hardware* measures the effort invested into choosing, installing, and configuring RFID hardware. Integration of RFID hardware constitutes an important activity during an RFID implementation project since even the most advanced RFID backend systems will provide little value if the RFID hardware does not work correctly and reliably. The final aim of the RFID hardware integration is to achieve a perfect fit of the RFID reader infrastructure including user frontends, sensor shielding, etc. with the operational environment. The experts confirmed our assumption that *Integration of RFID Hardware* has a positive impact on the *RFID Effects*.

Internal Environment

In the category *Internal Environment*, all company internal variables that have a significant impact on the value creation of RFID systems are summarized.

Ex Ante Validation of Project Feasibility and Value measures how much effort was invested into validating the technical feasibility and business value of a RFID project. Technical evaluation includes testing RFID hardware in realistic conditions, e.g., by conducting pilot studies before beginning with the large scale roll out (cf. Dvir et al. 1998). A sound validation of profitability should include a diligent cost/benefit analysis as well as a realistic value proposition based on accepted estimation techniques (Angeles et al. 2001, Dvir et al. 1998). We expect a positive impact of this variable on the *Implementation Success* and the *RFID Effects*.

According to Nah et al. (2003), the variable *Top Management Support* measures the commitment of the top management regarding RFID introduction. *Top management support* is an essential ingredient for the success of many types of IS. It guarantees that IT projects are approved as well as aligned with the business goals of the company. We expect a positive correlation between *Top Management Support* and *RFID Business Success*.

Through the variable *Availability of Expertise*, we intend to measure the level of technical and process expertise of the people who were involved in the RFID project. In addition to the sheer quantity of employees being staffed on the RFID project, their degree of expertise plays an important role (Nah et al. 2003). The RFID experts mentioned that RFID implementation teams should consist of regular employees as well as external consultants that bring in former experience. Further, they expect a positive correlation between *Availability of Expertise* and the variables measuring *Implementation Success* as well as *RFID Effects*.

External Environment

The category *External Environment* refers to external variables that may affect the value creation process of RFID projects.

The variable *Involvement of Business Partners* measures the degree to which business partners were engaged in the implementation of RFID and has proven to be a highly relevant factor in ERP adoption (cf. Bradford and Florin 2003) and Electronic Data Interchange (EDI) technology for logistic operations (cf. Chwelos et al. 2001). We believe that the involvement of suppliers or customers, i.e. their RFID implementation support as well as taking into account their specific requirements towards RFID, can be crucial for realizing RFID's value.

Use of Standards measures the degree to which a company implemented RFID related standards. The existence and use of standards are expected to play a significant role for the adoption and successful implementation of RFID in logistic operations (cf., e.g., Sharma et al. 2007). It eases the interoperability of the RFID system with other enterprise systems und thus supports integration. We hypothesize that the *Use of Standards* has a positive impact on the *Implementation Success* as well as the different *RFID Effects*.

CONCLUSION AND FURTHER STEPS

Although RFID technology has become a standard in various niche applications, it is still not widely used in logistic applications. We have therefore begun to investigate the factors determining the success of RFID projects in this domain and especially under which circumstances RFID provides the highest business value. Instead of speculating about particular kinds of RFID benefits, we plan to measure its impact on logistic operations using the survey instrument developed in this paper. As documented in the corresponding sections of this work, our measurement scales have undergone extensive testing and evaluation and will be published on our project website (Kunz and Goebel 2009) in order to support similar research efforts.

The hypotheses motivated in this document will soon be tested using a representative sample of RFID adopters and the structural equation modelling methodology.

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